DOCUMENT RESUME

ED 383 315 IR 017 170

AUTHOR Knupfer, Nancy Nelson; And Others
TITLE A Collaborative Multimedia Development Project for Rural Training: Results of a Beta Test and Adjustments to Design.
PUB DATE 95
NOTE 11p.; In: Proceedings of the 1995 Annual National Convention of the Association for Educational Communications and Technology (AECT), (17th, Anaheim, CA, 1995); see IR 017 139.
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Access to Information; Adult Education; Computer Mediated Communication; Continuing Education; *Distance Education; Educational Assessment; *Educational Needs; Educational Quality; Information Services; *Instructional Development; Learning Modules; *Multimedia Materials; On the Job Training; *Rural Population; *Social Workers; Staff Development
IDENTIFIERS Beta Binomial Test Model

ABSTRACT

In an attempt to improve services to rural populations, distance education has become an increasingly popular form of continued training to adult audiences. The increasing workplace demands on social workers require a feasible solution to providing on-the-job training for those who reside in both urban and rural areas. Social workers need to know more information to keep up with changing policies and provide quality services, while at the same time increased responsibilities make it more difficult to leave the office for training or education. Following a needs assessment, multimediated training for social work professionals was planned. The first of 10 modules was designed, developed, and beta tested prior to field placement, and this paper reports the results of the beta test aimed at checking the perceived quality of the multimedia lesson. The trainees were social workers who lived in rural areas and the developers were a team of people with various professional skills. In general, the subjects responded favorably to the multimedia training. The design adjustments recommended from the beta test can be categorized into three areas: content; instructional design; and technical integrity. (Contains 33 references.) (Author/AEF)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☐ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

ED 383 315

Title:

A Collaborative Multimedia Development Project for Rural Training: Results of a Beta Test and Adjustments to Design

Dr. Nancy Nelson Knupfer
Kansas State University

Ms. Doreen Barrett
Kansas State University

Dr. Okhwa Lee
Korea Educational Development Institute
Seoul, 137-791, South Korea

IR017170

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
S. Zenor

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

BEST COPY AVAILABLE

Vast numbers of adults in our changing society need specialized training to perform well on the job. Yet, that training often eludes people who live in rural areas, for they often have difficulty finding opportunities to receive further professional development. In an attempt to improve services to rural populations, distance education has become an increasingly popular form of continued training to adult audiences. The growing emphasis on distance education recognizes the needs of rural professionals who may not have the time or resources to travel to more central training sites.

Like some other professions, the increasing workplace demands on social workers require a feasible solution to providing on-the-job training for those who reside in both urban and rural areas. Social workers face a difficult situation; they need to know more information to keep up with changing policies and provide quality services, while at the same time increased responsibilities make it more difficult to leave the office for training or education. While distance learning opportunities have multiplied greatly in the past several years, the lack of relevant course work and access to the technology necessary to participate in these opportunities may prohibit the wide use of distance education for rural social workers.

There is a critical need to provide carefully designed training to meet the challenges rural social workers face, yet limited resources for staff development within the social work agencies create a difficult situation in meeting this training need. The consultation and assessment process for planning staff training becomes vital in this situation because any training offered must wisely utilize the limited resources by concentrating them on the most essential needs. Schoenmaker (1993) addresses this phenomenon and reveals a trend toward better communication between trainees and training developers in order to validate design decisions prior to developing the training materials. The training team in this study is practicing such communication.

Following a needs assessment, multimediated training for social work professionals was planned. The first of ten modules was designed, developed, and beta tested prior to field placement.

This paper reports results of a beta test specifically aimed at checking the perceived quality of a multimedia lesson prior to its release to a field test situation. It represents one step within the process of maintaining communication between the trainees and the training developers. In this case, the trainees are social workers who live in rural areas and the developers are a team of people with various professional skills.

BACKGROUND

Collaboration between two major institutions in a rural midwestern state identified specific training needs for child welfare workers and a five-year plan to meet them. The State Department of Social and Rehabilitation Services (SRS) contracted with the a major state university to develop a series of ten multimedia lessons (modules) for child welfare workers that would emphasize the educational needs of workers in the rural parts of the state.

The first step of the learning process assessed the workers' perceptions of their needs. The second step developed a plan to meet those needs. The third step involved design and development of educational modules using multimedia (videodisc, computer, workbook) for the delivery. This paper reports on the beta test phase of the first module of the project, which was intended to help guide the project toward improvement prior to releasing the module as a finished product. The beta test investigated user opinions about the content, instructional design, technical integrity, ease of use, and general quality of the module. Because people's opinions about self-efficacy, ease of use, and quality can influence their attitudes toward the instruction and in turn, influence performance and implementation patterns (Fullan, 1982; Klein, Knupfer, & Crooks, 1993; Rogers, 1983; Soltani, 1995), it is important that designers consider learners' opinions about the quality of material in terms of its usability and perceived value.

This program was designed so learners could set the pace of the lesson, and work through it at a rate commensurate with their available time, ability, and motivation. The learners have the option to start and stop at any time, and to repeat portions when necessary or desired.

The underlying rationale for self-pacing is that individuals learn at different rates. One claim made in favor of using technology for instructional is the ability of technology to adapt instruction to individual differences thereby gaining efficiency while at the same time promoting achievement Semb et al (1993).

Research clearly demonstrates that a variety of self-paced formats such as computer-based instruction (Bangert-Drowns, Kulik, & Kulik, 1985; Kulik & Kulik, 1987, 1989; Kulik & Bangert-Drowns, 1985; Orlansky & String, 1981), Bloom's Learning for Mastery (Kulik, Kulik & Bangert-Drowns, 1989), and Keller's Personalized Systems of Instruction (Kulik, Jaska, & Kulik, 1978) engender more positive attitudes about learning than conventional instruction. In addition, they are more effective, efficient, and preferred by the learners. (Soltani, 1995)

Formative Evaluation

It is helpful to think of formative evaluation as an explicit stance throughout the design process in which one collects data and uses them to inform the design procedures. While the project is still fluid, the beta test serves as part of the formative evaluation. The results of the beta test will be applied to design adjustments in this first module and the remaining nine modules.

Several researchers have developed a basic set of categories by which instructional software can be evaluated. For example, Morrison, (1987) placed maximum emphasis on the facet of interactivity which he defined as 'the learner in conversation with himself over the material to be learned'. He addressed the idea of adaptability where the program gives control back to the learner. Morrison claimed that well-designed products offer users an opportunity to find individual pathways through material and encourage learners to develop higher cognitive skills of self-assessment and evaluation of their own learning style and patterns.

Plowman(1989) explored such facets of learning design in as it specifically applies to interactive video. Important categories for evaluation which emerged include considerations of navigation and mobility through the software, physical aspects of human-computer interaction, screen presentation, quality of learner interactions, consistency of appearance and functionality, visual clarity, legibility, access to support in the form of 'help' and 'next' options, availability of a bookmark facility, user support tools like a glossary or other reference items, the style of user interface which might embody windows or other devices to maximize the amount of easily available information. The design of this project considered all of those factors, plus some additional ones.

Instructional Courseware Design

A courseware production system has been defined as the entire set of activities beginning with vague ideas or concepts to be taught and ending with finished materials for the users (Karrer, 1987). A production strategy means the combination of resources to set up and run a production process of courseware development; it must address the questions of manpower, required skills, and tools for development (Karrer, 1987).

Many authors have called for a team approach to courseware development. Ally (1985) suggested a five-member courseware design team which included a manager, instructional designer, computer specialist, communication specialist, and content specialist. Collis and Gore (1987) called for a collaborative model which included in its design a rigorous system which enabled team members to check and re-check work done by themselves and others by assessing congruency at several points in the development process. Faiola (1989) described the traditional team with one more person, the graphic or visual specialist. Because assessment is such an important part of the process Collis and Gore suggest placing in the collaborative model a step for field testing prototypes.

Because of the specific nature of the profession, social workers can have a tremendous impact upon human lives at particularly vulnerable times. Therefore, it is important that they receive ongoing education that will enhance their practical, applied skill concerning human services. Reay (1986) argues in favor of changing the focus of social work training from content issues to process issues. This could be done by limiting the theoretical information and choices, and rigorously encouraging students to master conditioned response (CR) learning and progress to understanding the learning process and applying the theory. Using this approach of embedding theory in practice, presents on an opportunity for the combination of modern technology and adult methods of learning to help students master the process of systematically applying theory to practice.

General psychological research and theory yield fundamental, widely generalized principles concerning how individuals think and learn. General psychological principles are largely media-independent. Psychological constructs such as schemata (Norman, Gentner, & Stevens, 1976; Spiro & Anderson, 1981);

meaning (Bandura, 1971); elaboration (Wagner & Rohwer, 1981); and situated cognition (Brown & Duguid, 1993; Suchman, 1991) emphasize how individuals organize and retrieve knowledge and establish meaning, and hence have far reaching implications for the design of learning systems that will allow the application of theory to practice.

Motivational Adult Instruction

Designing instruction for adult learners must take in those special considerations that are a major factor in adult learning. Adults have specific and unique motivational needs. The motivational aspect of the design can increase the learners efforts and attract learners to the instructional content and methods. (Keller, 1983) .

The motivational instruction can increase the amount of time and effort the learner will put into the task. Keller (1987), Keller and Suzuki (1988) as well as Keller and Kopp (1987) identify four categories of motivating strategies in learning situations, which include: attention, relevance (Keller's ARCS Model), confidence, and satisfaction. All of these strategies were incorporated into the design of this program. The needs of the learner were assessed and a design team addressed each aspect as follows:.

Attention. Content related anecdotes, case studies, and biographies are appropriate along with animation and sound. (Keller, 1987) The specific content developed by the subject matter experts contains all the current topics and issues pertinent to the social workers. The appropriate designs by the graphic artist take into consideration what is appropriate for the user/client

Relevance. Showing how the instructional materials relate to specific and current needs. How the instruction and information relates to ones job, and to real life.

Confidence. Giving the learner the locus of control. Throughout the program, the user has options, the ability to make choices and the freedom of navigation.

Satisfaction. Using skills learned in simulated situations Keller & Kopp (1987). The interactive video component takes the learner into environments which in effect lets you think while seeing and doing.

Adult professionals typically need to improve work performance. The computer-based interactive videodisc training program, has the potential to assist in learning and thus is very motivational.

Continuing Education

Computer-based simulations, especially those incorporating interactive video capabilities, have been demonstrated as effective instructional methods in medical, industrial, military and business context (Reeves, 1988). One positive aspect concerning this formative evaluation is that the module was previously approved for three continuing education credits.

Individualized Learning Process

According to Gotz, (1990), the learner can designate the time and place of learning. Advanced programs offer different paths of instruction in the processing of instructional material. The amount of material can be selected according to the skills and qualifications of the learner. The learner can call up help programs and systematically prepare for tests through simulations and visual instruction. A knowledge control of or classification of tests results can be integrated into the program and the learning sequences can be repeated as often as needed.

Distance Education

Distance Education, although long established, is currently in a stage of rapid evolution. The most fundamental motivation for distance education, that of reaching learners who are geographically hindered from meeting in a traditional setting, has been expanded to include motivations such as time tailoring and flexibility of learner characteristics. At the same time, advances in the technological media are adding new dimensions to distance education. In particular, the contribution of 'electronic distance education' strategies with respect to the problems of inequities in opportunity for isolated learners or learners with special needs is becoming increasingly recognized (Stubbs & Burnham, 1990).

Social and Rehabilitative Services was especially supportive of the project because of the large number of social workers from rural areas that would be trained.. They need to receive comparable services and have equity of access. The computer-based interactive videodisc program is meeting that need.

Mecklenburger (1990) stated that an advantage of multimedia and the capabilities it adds to distance learning is that learners can learn wherever they are. One of the advantages of this is anytime, anywhere learning.

Effects of Multimedia

The popularity of electronic learning, especially interactive multimedia, centers around the potentials of the media. Kelly (1990) cited four such potential:

1. The new media provides rich opportunities to learn. The combination of sight, sound, and interactivity provides opportunities to learn new things without ever leaving the classroom.

2. The media also provides the unexpected benefit of increasing opportunities for teaching people to work in teams and honing other interpersonal skills.

3. The technologies can make it easier to meet the varying needs of individual learners by being able to : diagnose what the learner knows; identify any learning difficulties the learner might have; and then attend to those needs. Also, the technologies enable the learners to go at their own pace.

4. The new technologies can provide new tools to assessment of skills.

Research provides ample evidence for the power of visuals and interactive multimedia to enhance learning (Carlson & Falk 1990-91; Dwyer 1982, 1978; Knupfer & Clark, 1992). This multimedia module had the potential to offer visually rich instruction.

RESEARCH QUESTIONS

Several research questions were of interest. The research questions of particular interest in this formative evaluation were:

1. Do learners like the module?
2. Do learners believe that the lesson is realistic, valuable, and relevant?
3. Do learners believe that the multimedia format works well for delivery of this lesson?

4. Do learners believe the video sequences are valuable?
5. Can learners navigate easily within the lesson?
6. Are learners likely to use the extra features, such as the glossary or content map?

7. Does the module function properly, including the bookmark feature?
8. What strengths, weaknesses, and suggestions do the learners have?

9 How much time does it take to complete the module?
10. Are there differences in the way social workers and instructional designers rate the module?

METHODOLOGY

Subjects

Subjects for this study included twenty people; 11 were social work graduate students or professionals, and 9 were graduate students of educational technology. The social work subjects were selected because they would be typical of the group of learners for whom the instruction was designed. They likely would represent about the same technical skill level and would have background knowledge necessary to judge the merit of the content and presentation style of the training. The educational technology students were typical of instructional designers who would be responsible for developing similar multimediated lessons.

Materials

Subjects in this study used the multimediated lesson titled "Child Development" which is the first module of the Building Family Foundations series. In addition, they completed a 43-item questionnaire.

The multimediated lesson was based on an IBM 486 computer system with a Pioneer videodisc player. It used Toolbook as the authoring system.

A set of written materials composed a workbook that accompanied the electronic part of the lesson. The workbook was designed as a reference that social workers could keep close-at-hand and xerox as needed for doing their job independently or working with clients. The workbook contained instructions for starting the lesson, and any text-based information that a social worker might like quick access to, especially when working with a client. For example, the workbook contained a glossary of terms, informational articles, references that a social work might like to refer to, and forms that could be duplicated and used on the job or distributed to clients.

The survey instrument used to collect the data contained 29 items based upon a four-point Likert-type scale, 10 open-ended questions, and 4 rank-order questions asking what mode of delivery subjects would prefer for future lessons.

Procedure

Each subject was given a brief introduction to the equipment and asked to complete a learning module independently and in its entirety. The instructions included a request for each subject to try to use the bookmark feature one time; other than that, no specific requests were made concerning the process of module completion.

Immediately after completing the module, each subject filled out a questionnaire about the experience. The completed questionnaire was collected before the subject left the site. Summary statistics were gathered and changes recommended based upon the beta test.

Data Analysis

The data were analyzed using summary statistics, chi square analysis, and qualitative analysis. The structured questions combined with the open-ended questions provided an opportunity to gather the kinds of information that we anticipated was important as well as the spontaneous reactions of the subjects.

RESULTS AND DISCUSSION

The subjects who used the multimediated lesson represented two occupations and thus, two points of view; those knowledgeable in the social work content and those knowledgeable about interactive courseware design. The social work subjects (SW) were likely to provide information about such things as content accuracy, flow, relevancy, and presentation style, while the instructional design (ID) subjects were likely to react to such things as human interface design principles, graphic design and use, navigation, and other features related to instructional design.

One potential area of difficulty was experience with this type of mediated instruction. Of the 11 SW subjects, 4 had used a multimediated lesson before while 7 had not, and of the 9 ID subjects, 8 had used a multimediated lesson before while 1 had seen multimedia but had not actually experienced using it. Ages ranged from 21 through 47 years, with an average SW age of 27, an average ID age of 37, and an average of 31 years overall.

Realism, Valuable, and Format

The overall reaction of both groups was that this kind of program is valuable for learning this type of content and it is especially useful in the case of a distant audience, such as rural social workers. The SW subjects were relatively new users of technology and their reactions displayed overall enthusiasm of having a well-organized instructional program that offered them audio, video, dynamic graphics, and text. Approximately 90 percent of the SW subjects and 100 percent of the ID subjects agreed or strongly agreed that the content was accurate, while 100 percent SW and 100 percent ID subjects agreed or strongly agreed that the content was realistic.

Concerning relevancy, 82 percent of the SW subjects and 78 percent of the ID subjects believed that the content was relevant to their needs, while 90 percent of the SW and 89 percent of the ID subjects believed that the multimedia format presented a convenient way to learn the material. Even though the ID subjects were not studying social work, their notation of relevancy would reflect the generic nature of interest in child development. The module was designed to help social workers recognize children who should be referred to a specialist for evaluation and potential help. Certainly any parent or person who works with children in any way would have some interest in the topic.

Thirty-six percent of the SW group and 72 percent ID group believed the content needed more depth, while 91 percent SW and 100 percent ID agreed or strongly agreed that the module content was clear. Virtually all of the subjects believed that the lesson contained valuable information and that it was valuable learning experience for them to use this form of instruction.

All of the SW subjects and 90 percent of the ID subjects believed that this style of lesson was a good way to learn the content, while 72 percent SW and 87 percent ID were satisfied with their own performance.

Video

One area of potential strength for this lesson was the video component. Approximately 80 percent SW and 66 percent ID agreed or strongly agreed that the video information helped them to understand to concepts. None of the SW subjects believed that the video was not relevant, but 22 percent of the ID agreed that the video was not relevant to the lesson content. The ID subjects seemed to look more intensely at the actual design and expressed some concerns including a more critical evaluation of the video portions of the program.

The length of the video segments in relationship to the information given and the relevancy of specific visuals were critical points. Subjects expressed a desire to stop the video and replay only small sections rather than longer pieces. This suggests a need to make sure there is a good video match, but even further that shorter segments of video be used so that learners can repeat targeted sections.

Navigation, Functionality

Navigating through the software was a potentially problematic area for SW subjects who had little experience with this type of mediated instruction. Ninety percent of the SW subjects and 100 percent of the ID subjects agreed or strongly agreed that the module content was easy while no one thought it was difficult or hard to use. Despite that fact that no one thought is was difficult, 9 percent of the SW subjects and 22 percent of the ID subjects agreed or strongly agreed that the content was confusing.

Even though the design team advocates users choice, there are some controls on navigation to assist with directing the learners to prerequisite information or the desire of the subject matter expert (SME) to be sure that the learners cover a certain area within a segment. The ID subjects saw this as restrictive, but made the comment that this may be a good design feature for new users to help prevent them from getting lost within the program. The beta test revealed need to make sure all check marks stayed in place for the duration of a learner's use of a module. The check marks indicate topics and subtopics that have been completed. Learners wanted to be able to back track one screen at a time to recheck information rather than going back to the beginning of a section.

The bookmark feature was designed as an easy way to restart the lesson after taking a break.. It kept information such as check marks to record progress and the specific place where a user left off during the last usage. Learners' individual records were stored on their own floppy disk upon exiting form the program. Among the information tracked is length of time spent on the module; that is important to enable learners to get continuing education credit.

Although hot words with definitions in pop-up boxes, an on-line glossary, and content map to check where they were and where they could hop to were included, but they were very virtually unused. All subjects tended to go straight through the program in a linear sequence. The bookmark feature was something that might be used in a real work setting, but here each person only used it as part of the test.

The suggestions gathered led to changes in content, screen design, and general flow of the program. It will be important to give some sort of orientation to the next group so that they know how specific features can help them. To help clarify the lesson and alleviate confusion, revisions to the content introductions, transitions, areas of emphasis, and content map were made.

Time

The average length of time in minutes to complete the module for SW subjects was 138 (low 50, high 230, SD 48.95) and for ID subjects was 142 (low 90, high 180, SD 30.32). Approximately 80 percent SW and 55 percent ID believed that the lesson was about the right length, while 9 percent SW and 11 percent ID believed that it was boring.

Strengths

The overall reaction about the strengths of the lesson referred to the power of the video to help visualize concepts and the good organization and logical flow of content categories. The aural, visual, and textual interaction with the learner was viewed as an appropriate way to accommodate the different learning styles.

The SW subjects were particularly pleased with the opportunity to see actual vignettes of situations that related directly to the content. both SW and ID subjects believed the navigation was friendly enough to help alleviate some potential confusion about certain areas of the content.

Weaknesses

The main weaknesses of the lesson concerned the relationship of review and test questions to content presented, the relevancy and length of video segments, and the inability to go back a few screens without taking a large jump backwards.

Although the instructional designer had worked with the SME to write appropriate objectives and good questions matched to the objectives, the content presentation fell short on emphasizing the important points. In fact some questions contradicted the content and therefore were confusing. Revisions to the lesson presentation were necessary to provide enough clear and consistent information related to the test questions.

Colors and Graphics

Reactions to colors and graphics are most likely related to the learner's experience. The SW subjects like the way that the graphics were presented and the colors that were used, while the ID subjects wanted the graphics to be more lively and found the colors dull. The two groups had opposite views here, reflecting their experience and expectations.

CONCLUSIONS

In general, the subjects responded favorably to the multimedia training and believed that the video component added value to the experience through the use of examples and demonstrations. A few SW subjects expressed the preference for traditional classroom instruction where they could ask questions. The more experienced social workers made suggestions to improve the content, while the less experienced students and instructional designers focused their comments more on the technology and program flow.

Although the design team had built some fancy features into the module, the subjects did not use most of them. That could have been due to their limited experience with multimedia and technology in general, a way of presenting the features that is less than obvious, or lack of time to explore.

The design adjustments recommended from the beta test can be categorized into three areas: content, instructional design, and technical integrity. With the subject matter expert being a member of the design team, the content and clarity was one of the positive features. In addition to attending to the features noted earlier, we recommend chunking the information better and adding even more variety of perspectives to cover a diverse population of learners. We further recommend the inclusion of a person within the design team who could be classified as an expert who can authenticate certain ideas from within a cultural perspective. In this case, the social workers were very helpful as part of the beta test team. Experts on child development and special education were also included.

The instructional design features mentioned earlier were corrected and the actual design interface was revised to improve navigation. Changes were made in fonts, colors, layout of the screen. One drawback of the SMEs being the project directors has been pressure to present information in a way that the designers felt matched linear video, but not necessarily multimedia. Those issues were revealed and addressed with each member of the design team contributing a strength.

The decision was made to revise the program that records the learner's path throughout the program. The bookmark feature was modified and improved to allow more flexibility. It is also important to pinpoint a the specific features of hardware that the learners will have in their various remote sites because a few of the keyboard variations can make difference in program functionality. The programmer made changes to avoid sensitive features that can be anticipated, but this limits our ability to be specific with learner instructions.

We recommend that the module be field tested in a variety of sites prior to full distribution. Within the field test we recommend that the data collected include measures of attitude, confidence, expectancy, comfort level with technology, knowledge, achievement, and satisfaction with the multimedia lesson.

REFERENCES

Ally, M. (1985). A team approach to courseware design. *Educational Technology, 25* (7), 28-30.

Bandura, A. (1971). *Social learning theory*. New York, NY: General Learning Press.

Bangert-Drowns, R.L., Kulik, J.A., & Kulik, C.C. (1985). Effectiveness of computer-based education in secondary schools. *Journal of Computer-Based Instruction, 12* (3), 59-68.

Brown, J., & Duguid, P. (1993). Stolen Knowledge. *Educational Technology, 33*, (3), 10-15.

Carlson, H. L. & Falk, D. R. (1990-1991). Effectiveness of interactive videodisc instructional programs in elementary teacher education. *Journal of Educational Technology Systems, 19*, (2), 151-163.

Collis, B., & Gore, M. (1987). The collaborative model for instructional software development. *Educational Technology, 27* (2), 40-44.

Dwyer, F. M. (1978). *Strategies for improving visual learning*. State College, PA: Learning Services.

Dwyer, F. M. (1982). A futuristic projection for the program of systematic evaluation. Paper presented at the annual international convention of the Association of Educational Communications and Technology, Dallas, Texas.

Faiola, T. (1989). Improving courseware development efficiency: The effects of authoring systems on team roles and communication. *Educational Technology, 29*, (8), 16-19.

Fullan, M. (1982). *The meaning of educational change*. New York: Teachers College Press.

Gotz, K. (1990). Interactive learning with the computer. *Educational and Training Technology International Journal, 28* (1).

Karrer, U. (1987). *Development of computer-assisted instruction curriculum materials: Results of a survey*. ERIC Document ED288 511.

Keller, J. M. (1983). Motivational design of instruction. In Reigeluth. C. M. (Ed). *Instructional design theories and models: An overview of their current status*. Hillsdale. N.J: Erlbaum Associates, 383-434.

Keller, J. M. & Kopp, T. W. (1987). *Instructional theories in action: Lessons illustrating theories and models*. Erlbaum Associates, Hillsdale N.J.

Keller, J. M. & Suzuki, K. (1988). Use of the ARCS model in courseware. In D. Jonassen (Ed). *Instructional designs for computer courseware*. New York: Lawrence Erlbaum.

Kelly, H. (1990). Technology and the transformation of American education. *THE Journal, 18* (1), 60-63.

Klein, J., Knupfer N. N. , & Crooks, S. C. (1993, Summer). Differences in Computer Attitudes and Performance Among Re-entry and Traditional College Students. *Journal of Research on Computing in Education, 25* (4), 498-505.

Kulik, J. A., Jaska, & Kulik C. C. (1979). A meta-analysis of outcomes studies of Keller's personalized system of instruction. *American Psychologist, 34* (4), 307-318.

Kulik, J.A., Kulik, C. C. & Bangert-Downs, R.L. (1985). Effectiveness of computer-based education in elementary schools. *Computers in human behavior, 1* (1). 59-74.

Knupfer N. N. & Clark, B. I. (1992). Tessellating with Logo: Effects on Visual Literacy. In Simonson, M. R. & Jurasek, K. (Eds.), *Proceedings of Selected Research and Development Presentations at the international Convention of the Association of Educational Communications and Technology (AECT).*

Mecklenburger, J.A. (1990). Educational technology is not enough. *Phi Delta Kappan, 72* (2), 104-108.

Morrison, D. J. (1987). Interactive learning systems and the learner. In F. Percival, et al, (Eds.), *Aspects of Educational Technology*, Vol.XX, 134-138. Flexible Learning Systems.

Norman, D., Gentner, S., & Stevens, A.L. (1976). Comments on learning schemata and memory representation. In D. Klahr (Ed). *Cognition and Instruction*. Hillsdale N.J: Lawrence Erlbaum Associates.

Plowman, L. (1989). Learning from learning theories: An overview for designers of interactive video. *Interactive Learning International, 5*, 165-174.

Reay, Ruth. (1986). Bridging the gap: A model for integrating theory and practice. *British Journal of Social Work, 16* (1), 49-64.

Reeves, T. C. (1988). Evaluating Interactive Multimedia. *Educational Technology, 32* (4), 47-53.

Spiro, R. & Anderson, R. (1981). Much ado about next to nothing: A rejoiner to Ausubel. *American Educational Research Journal, 18* (3), 271-272.

Wagner, M. & Rohwer, W. D. (1981). Age differences in the elaboration of inferences from text. *Journal of Educational Psychology, 73* (5), 728-735.

Semb, G. B. and others (1993). Long-term memory for knowledge learned in school. *Journal of Educational Psychology 85* (2), 305-316.

Shoenmaker, Jan. (1993). Linking new applications to new design paradigms. *Computer Education, 21*, 181-192.

Soltani, E. (1995). *Student preconception, mental effort and actual achievement from text, videotape, and interactive multimedia.* Unpublished doctoral dissertation completed at Kansas State University.

Stubbs, S. T. & Burham, B. R.(1990). An instrument for evaluating the potential effectiveness of electronic distance education systems. *American Journal of Distance Education, 4* (3), 38-50.

Suchman, L. A. (1991). *Plans and situated actions. The problem of human machine communication.* New York, NY: Cambridge University Press.